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| **Lesson Title:** Toy Car Lab |
| **Subject area / course / grade level: Science/ Sixth Grade** |
| **Introduction:** Jill drives her car forward while Jack records her distance from where she started at one second intervals. The data are recorded on a data table. Using the recorded data, Jill’s average speed during any time interval can be determined using the definition:  average speed  =  distance traveled divided by time traveled.  Another way to examine the data is to construct a distance vs time graph. The steepness of the graph gives you information about Jill’s speed. |
| **Lesson Length:To 50 minute lessons** |
| **Materials:** Science notebooks, Constant Velocity Toy Car, Stop Watches, Meter sticks, Interactive graphing software ChartTool (<http://www.onlinecharttool.com>). |
| **Lesson Overview:**  Students will “design” an experiment to determine whether the velocity of a car is constant. They will use their science notebooks to record the steps of the scientific method, record data, analyze data by using a graph they create using an online graphing tool and last, to communicate results by using large whiteboards. |
| **Tennessee Standards:**  GLE 0507. Inq. 2. Select and use appropriate tools and simple equipment to conduct an investigation.  GLE 0507. Inq.3. Organize data into appropriate tables, graphs, drawings, or diagrams.  0507. Inq. 2. Identify tools needed to investigate specific questions.  0507. Inq. 3. Maintain a science notebook that includes observations, data, diagrams, and explanations.  0507. Inq. 4. Analyze and communicate findings from multiple investigations of similar phenomena to reach a conclusion.  GLE.0507.11.1 Design an investigation, collect data and draw conclusions about the relationship among mass, force, and distance traveled. |
| **Lesson objective(s):**   * To design and conduct open-ended scientific investigations by measuring the constant velocity of a toy car. * Use appropriate tools and techniques to gather, organize, analyze, and interpret data. To understand why the international standard is used in measurement. * Synthesize information to determine cause and effect relationships between evidence and explanations. * Recognize possible sources of bias and error, alternative explanations, and questions for further exploration. * Communicate scientific understanding using descriptions, explanations, and models. |
| **ENGAGEMENT**   * Using their lab notebooks, students will be asked to observe the motion of a toy and to describe the motion under the heading “Observation.” If students have a difficult time describing what they saw, suggest they include what they observed about distance and speed. * Divide students into groups of three or four. * They are then asked to predict what a graph of distance versus time would look like. Ask each group to draw their predicted graph on their large whiteboard and take turns showing what they think the graph would look like. Make sure the following questions have been addressed after the discussion:   1) Is the speed of the car changing or staying the same?  3) How can we determine if the speed is staying constant?  4) What equipment would we need to do this investigation?  5) How would we record our data?  Ask students to draw their prediction of what they think the car will do with respect to time, velocity and distance under the heading “Hypothesis.” |
| **EXPLORATION**   * Provide instruction on how to keep a laboratory notebook showing materials, equipment and data table. * Explain to students that we want time to be the independent variable (plotted on the horizontal axis) and distance to be the dependent variable (plotted on the vertical axis). * Have students create a data table for their experiment under the heading, “Experiment” * Under the Heading “ Experiment,” have students indent and create a subheading called “Materials.” Have students list the materials used in the experiment. * Next, have students indent under the heading “ Experiment” and create a subheading called “Procedures.” Have students glue the procedures that have been handed out to them in their notebooks * Students should place a post-it note on the floor to mark the zero position, turn the car on and place it on the floor so that the back of the car is lined up with the post-it note. Release the car   and start the stop watch at the same time. After 4 seconds, the students need to place a post-it note on the floor behind the car to make the car’s position. Repeat this at the 8 second mark, 12 seconds and so on until all of the seven post-its have been used up. Stop the car and use a meter stick to measure the distance from the zero position to each post-it note. Record the distances in the data table.   * Have each group present their data table on their whiteboards to the class. |
| **EXPLANATION**  Speed and velocity are similar. While it's perfectly acceptable at times to use the two terms interchangeably, each can have its own distinct meaning.  **Speed** : the rate of motion and is calculated by dividing the distance an object travels by the time it takes to travel that distance.  **Velocity**:is a measurement of both the rate of motion (i.e., speed) plus direction. In other words, ten kilometers per hour is speed; east at 10 kilometers per hour is velocity. |
| * **ELABORATION** After all groups have finished collecting their data, ask the students if they are able to determine from the data table if the toy cars were moving at a constant speed. Ask them if they think a graph would help them decide if the cars were moving at a constant speed. * Have each group go to the free online graphing program ( <http://www.onlinecharttool.com>) and graph their data. Provide each student with a handout containing specific instructions on how to use the software. After each group has graphed their data, have them sketch their graph on their whiteboard. After each group has finished their white board, have them present them to the class. Ask the following questions:   1) What do all of the graphs have in common?  2) What do they think the straight line means?  3) Are there any differences in the graphs?  4) What is the formula for speed?  5) What part of this graph represents speed?  6) What does a graph with constant speed look like?  7) How would a graph with speed that is changing appear?  8) How do the graphs from the slow cars differ from the graphs of the fast cars?  9) Why is time to be the independent variable (plotted on the horizontal axis) and distance to be the dependent variable (plotted on the vertical axis)?  After the discussion, have students create a new heading in their notebooks called, “Data Analysis” and allow each student to sketch the graph in their lab notebook after their group uses the classroom computers to make their graph online.  Next, Students should create a heading, “Draw Conclusions” in their notebooks. Ask them to look at their graphs and tell what they learned about the acceleration or constant velocity of their toy car. See the Evaluation section below for specific questions that should be answered.  Each group should graph their results on their large whiteboard and include a statement that tells what they learned about constant velocity. Explain to students that this is the “Communicate Results” part of the Scientific Method. Scientists must let other scientists know the results of their research and must be able to duplicate research in order to validate it.  Student groups evaluate the other whiteboards and are asked:   * Were the graphs the same? Why were they different? * Did any groups have things left out (labels, titles, units)? |
| **EVALUATION**  Students need to write a conclusion to their lab activity. Questions that need to be answered in their lab books:  1) Describe the motion of the toy car. How do you know?  2) What does a graph of an object with constant speed look like?  3) Using the formula speed = distance/time, calculate the speed of your toy car.  **Reference:**  Adapted from the Modeling Physics Curriculum Constant Velocity Unit developed by Arizona State University. (©Modeling Workshop Project 2002)  http://courses.ncssm.edu/physics/Labs/PH355/CBL/CBL\_DVST.htm  **Equipment Sources**  To purchase the toy car:  1) at around $2.50 each (This requires a minimum amount):  Mark Tibor, Account Executive Westminster Inc. Toll Free: (800) 257.0824 Direct: (404) 917.2368 Fax: (888) 228.2082 Email: mark@westminsterinc.com  2) at around $8.00 each:  Arbor Science at <http://www.arborsci.com/prod-Constant_Velocity_Car-50.aspx>. Search for Constant Velocity Car Product ID: 44-1090. |